OpenMBEE

Open Model-Based Engineering Environment

Connected engineering information for a connected world

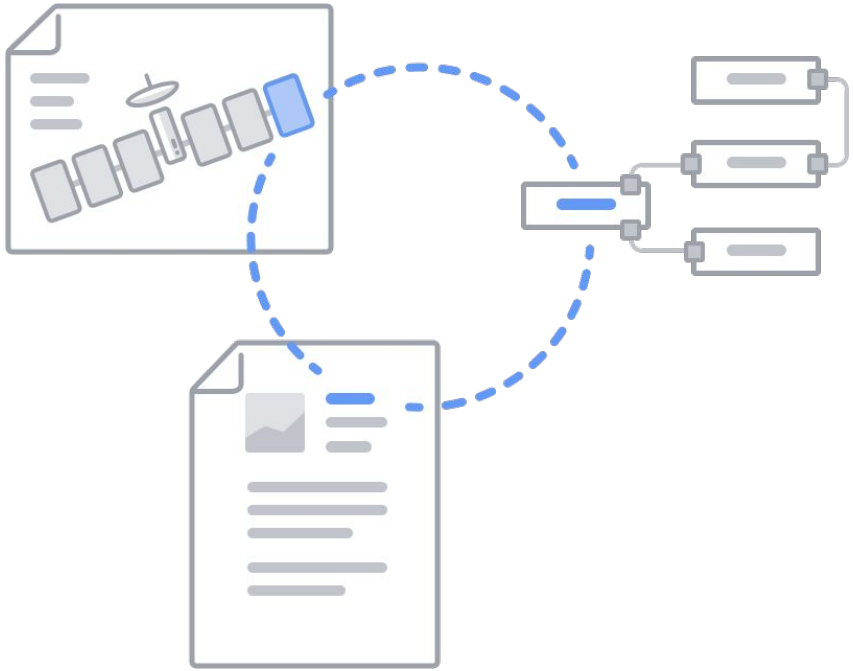
Robert Karban, Chris Delp
Jet Propulsion Laboratory, California Institute of Technology

MODELS 20, Oct 2020, Virtual

OpenMBEE.org

Open Model-Based Engineering Environment

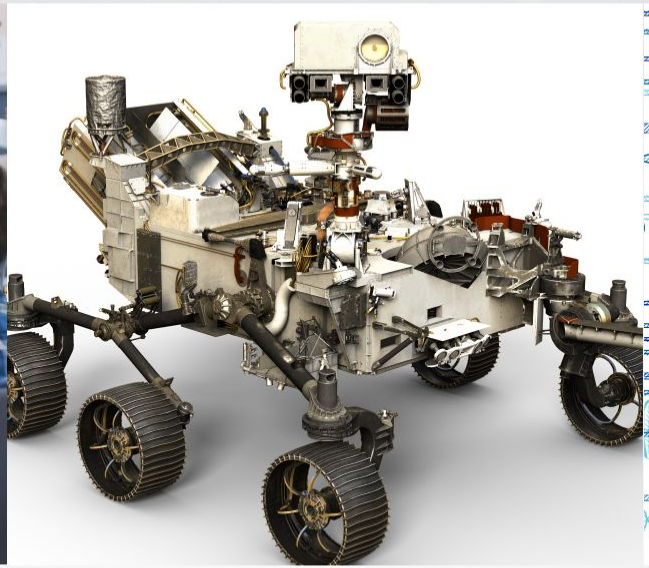
- OpenMBEE is a **community** for open source modeling software and models
  - Open source software activities
  - Open source models
  - Open source exchange of ideas
- Participants and adopters:
  JPL, Boeing, Lockheed Martin, OMG, NavAir, Ford, Stevens, Georgia Tech, ESO, ...
- > 400 members



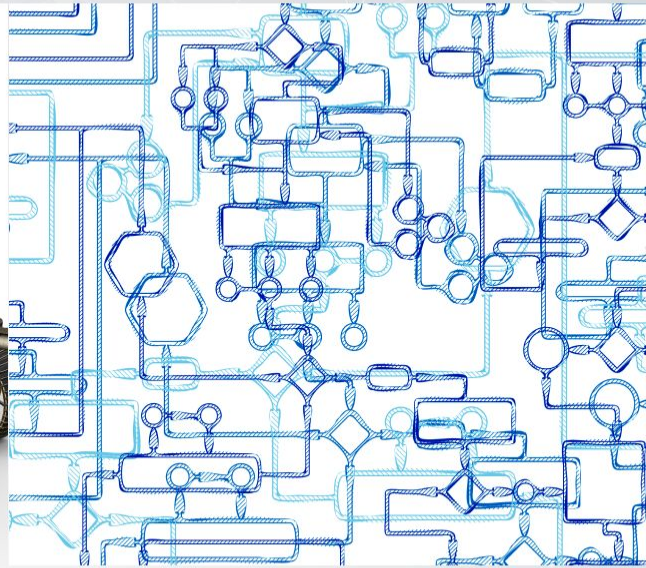
Linked Data Documents with OpenMBEE

Systems Engineers guide the concurrent collaborative design of complex technical systems

Leadership



Architect and Design
Cyber-Physical Systems



Manage Complexity

Flight project teams are large

A project starts simple

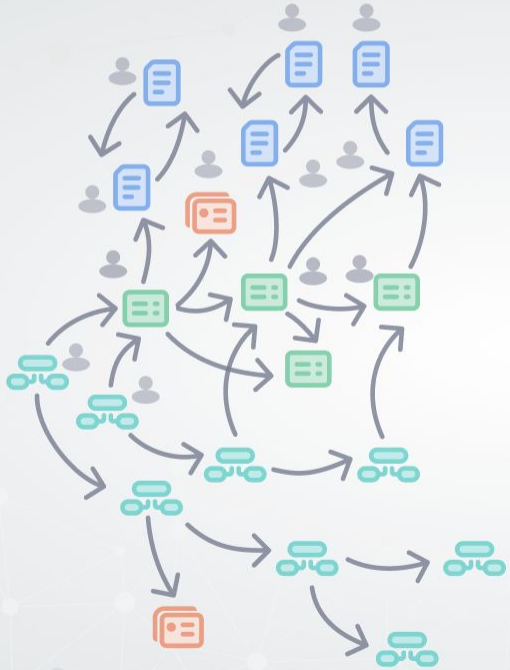
Engineers iterate on their models

Systems engineers enter this data into their rollup

They add it to a document and get inputs from others

And add it to a spreadsheet to track it over time

It can get complicated quickly



It can get complicated quickly

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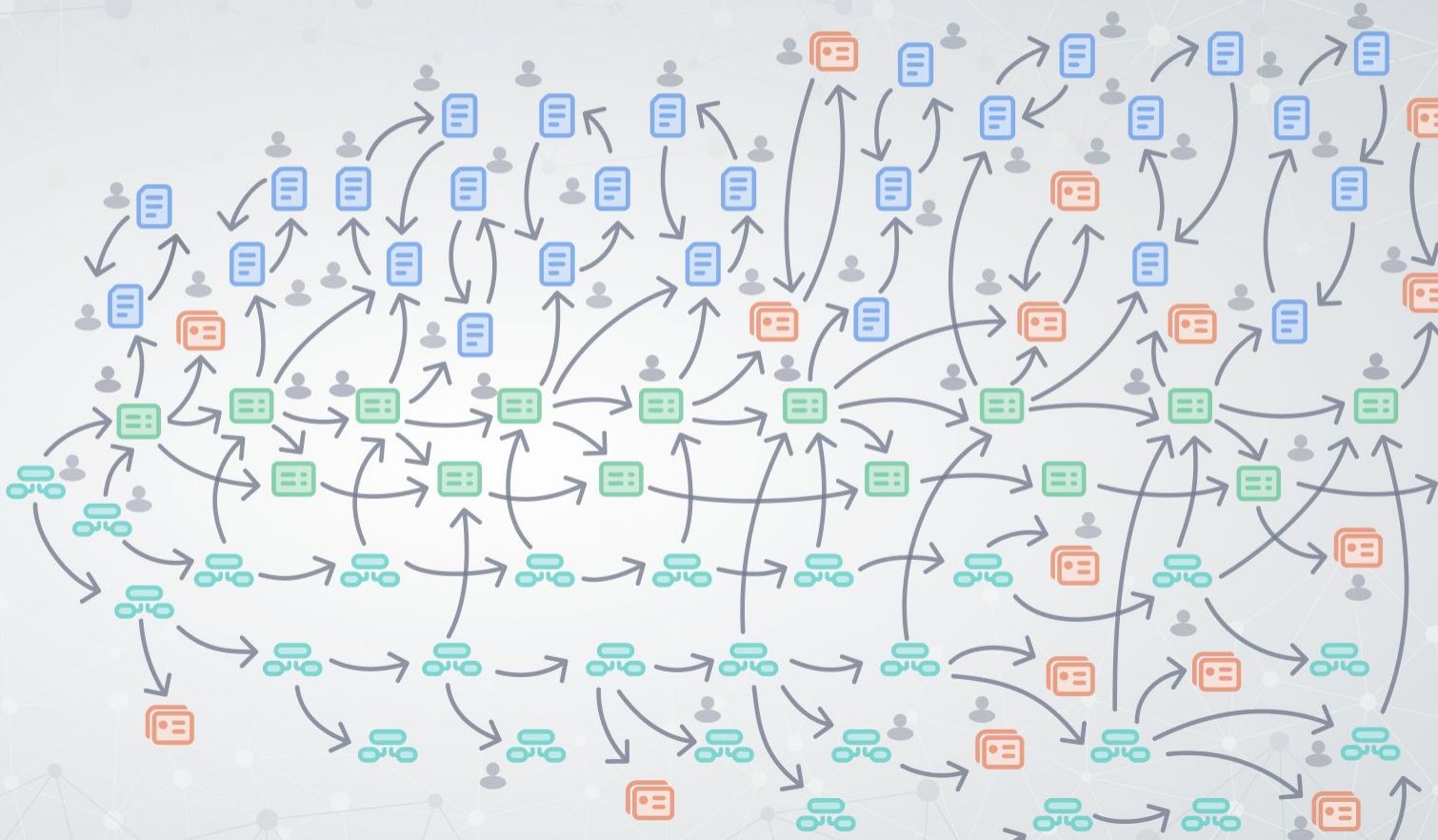
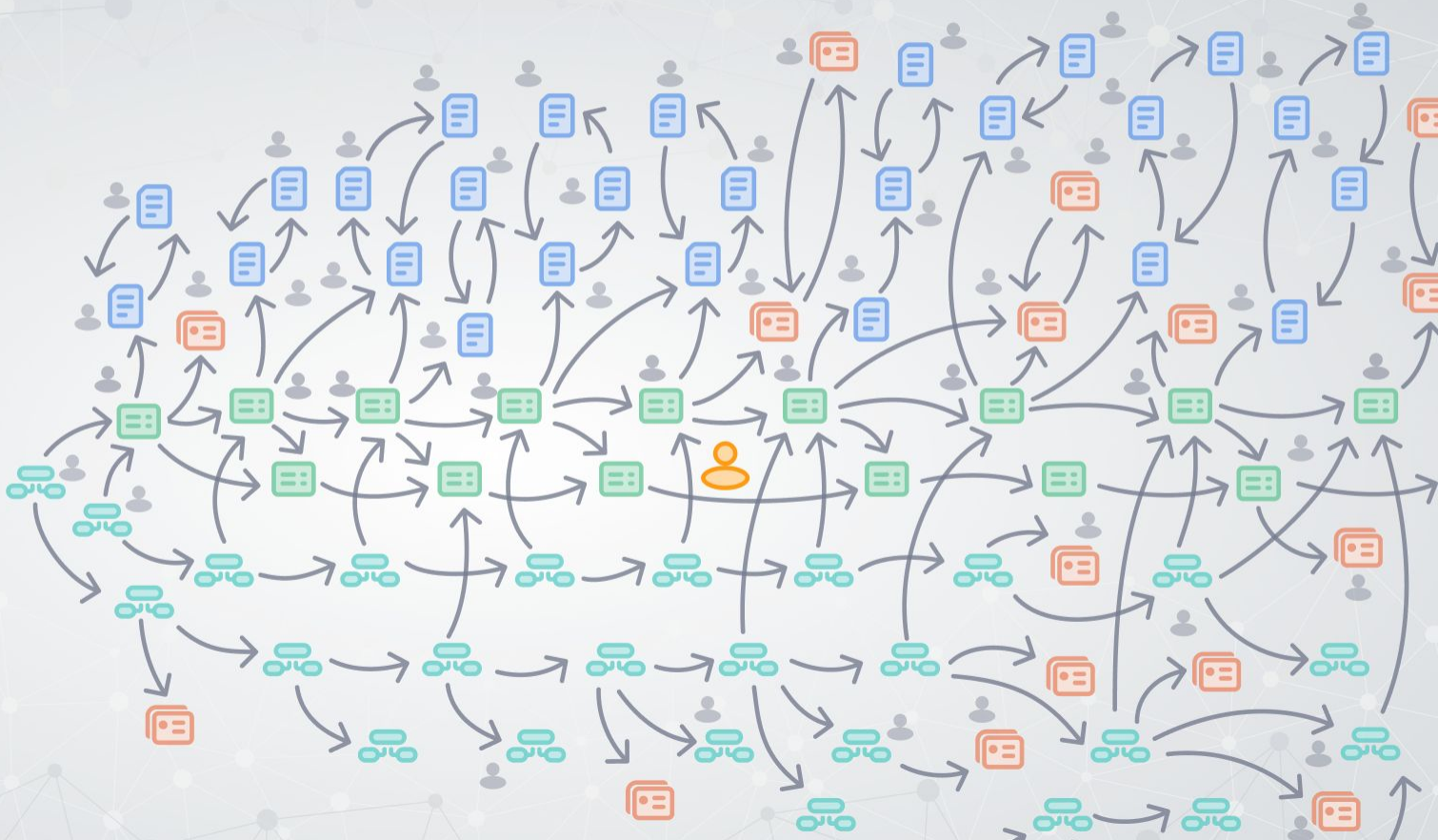


And become overwhelming...



Most of my job is data entry.
I want to do REAL ENGINEERING.

JPL Systems Engineer

> **Using engineers as information janitors isn’t the best use of their skill.**

JPL Systems Engineer

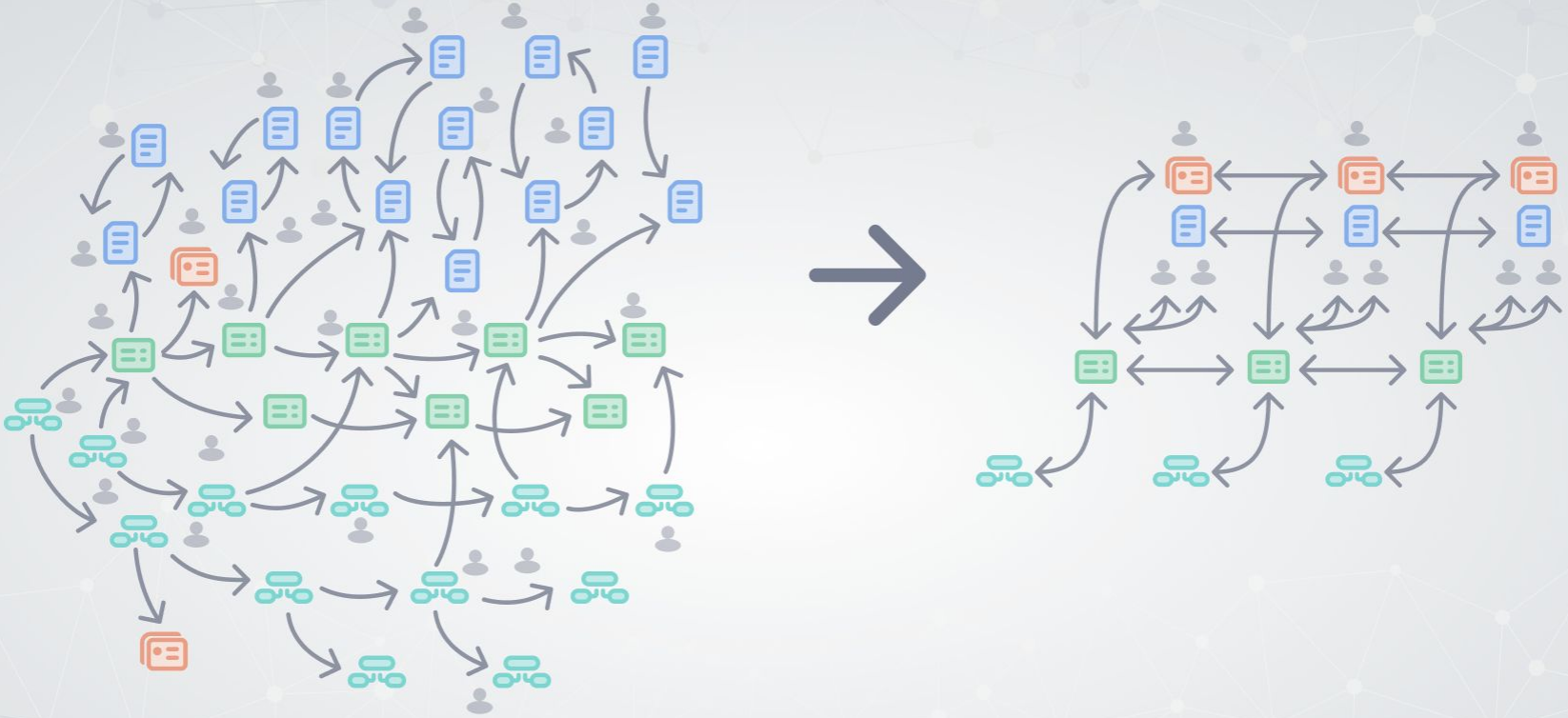
Real engineering vs. overhead

Repetitive Data Entry

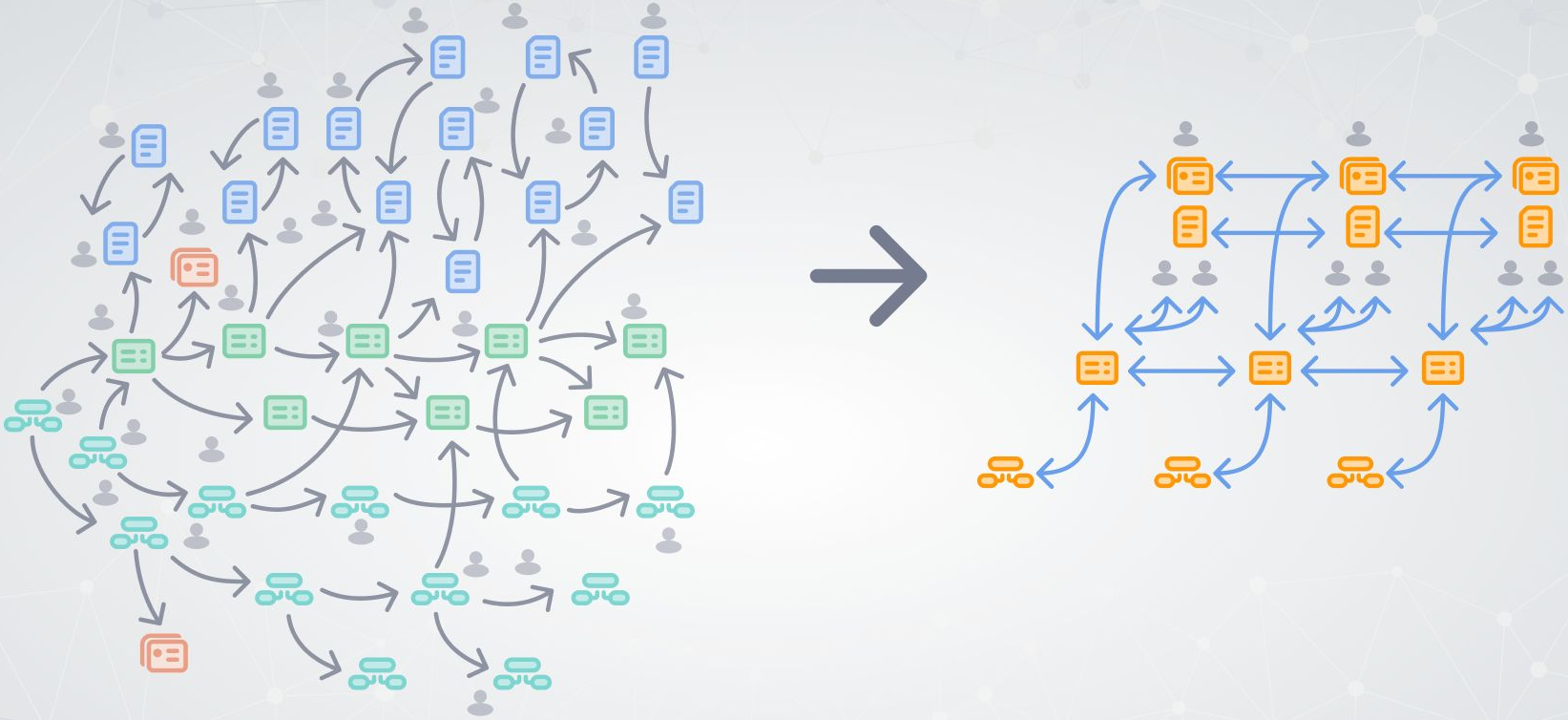
Version Confusion

Constant Searching

A better way...



A better way...



Connected information, connected engineers

OpenMBEE

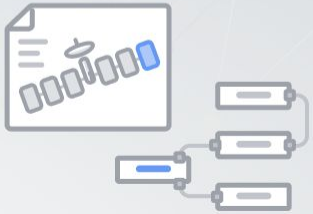
open source initiative

100% JPL
Core Components

TRL 8

Model Management System

View Editor & Platform for Model Analysis



Model Development Kits

Documentation and Training

Thirty Meter Telescope Model

OpenSE Cookbook

OpenMBEE

Thirty Meter Telescope Model

Model Management System

Authoritative Source

OpenSE Cookbook

Model Development Kits

Engineering Modeling

View Editor & Platform for Model Analysis

Document Authoring

Master Equipment List

Model Management System

Authoritative Source

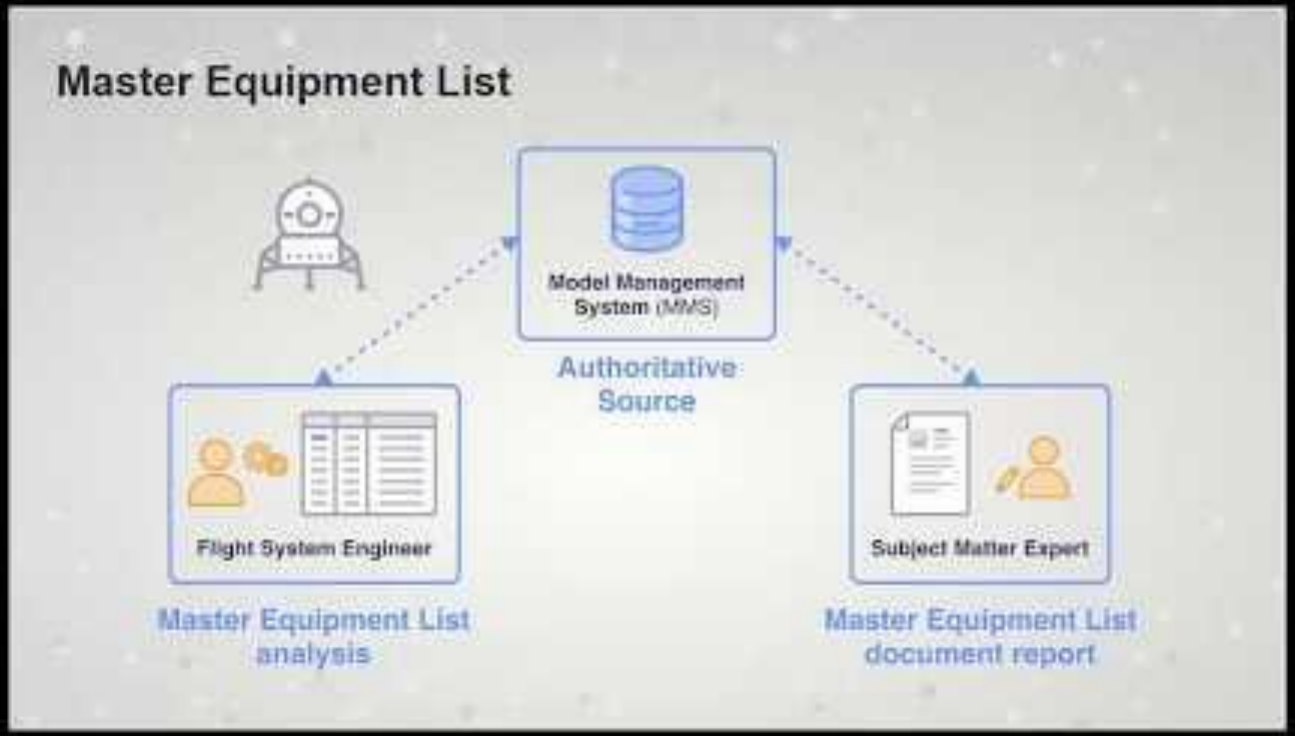
Flight System Engineer

Master Equipment List analysis

Subject Matter Expert

Master Equipment List document report

Demo


Master Equipment List
Model Management System (MMS)
Authoritative Source
Flight System Engineer
Master Equipment List analysis
Subject Matter Expert
Master Equipment List document report

OpenMBEE adopters and contributors

NASA

Mars 2020

Europa Clipper

ARRM

Mars Sample Return

MAIA

SWOT

NASA Pathfinder

Europa Lander

Science & Engineering

Thirty Meter Telescope

Japan Aerospace Exploration Agency

Stevens Institute of Technology

Systems Engineering Research Center

Georgia Tech Research Institute

Georgia Tech Aerospace Systems Design Laboratory

Industry

Boeing

Ford Motor Company

Lockheed Martin Corporation

Standards

Object Modeling Group

INCOSE

Vendors

Dassault Systemes

IncQuery Labs

Capella

Intercax

Tom Sawyer

Phoenix Integrations

Maplesoft

Flight Project Impact: Reduction of Overhead

Europa Clipper

100

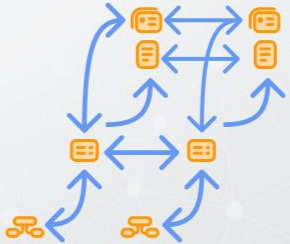
Concurrent users

230+

Documents and decision gate deliverables including

445,000

Connections between elements



The Mass and Power Equipment Lists produced by the model provided crucial support to the key mission architecture trades… A key enabler of this modeling capability came from components of OpenMBEE.

Todd Bayer, Flight System Engineer, Europa Clipper/JPL

Flight Project Impact: Technical Rigor

50

Concurrent users

Mars 2020

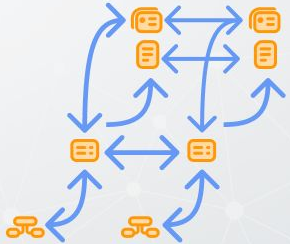
90+

Documents and decision gate deliverables including

- Reference Designator List
- Electrical Function List
- Electrical Functional Block Diagram

180,000

Connections between elements



...documents that were shared with the entire project and were used as the authoritative source of truth for key FSSE deliveries such as the: Reference Designator List, Motor MUX table, Electrical Function List.

Elyse Fosse, Mars2020 Flight System and
Mission System Systems Engineer

International Standards Impact: Digital Transformation

OBJECT MANAGEMENT GROUP®

Systems Modeling Language V2

60+ Organizations

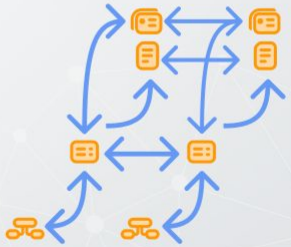
30 Contributors

100+ Consumers

6 Documents including

- SysML v2 RFP
- SysML v2 Submission
- SysML 1.x Specification

10,212 Connections between elements



The capability that OpenMBEE provides is helping to dramatically shape the direction of MBSE, and is turning out to be a critical enabler of MBSE as part of the digital transformation.

Sanford Friedenthal, Founder of SysML, INCOSE representative and Systems Engineering domain-specific interest group lead at Object Modeling Group

Aerospace Industry Impact: Enterprise Scalability

BOEING
Commercial Airplanes

1,000
Concurrent users

50
Programs

LOCKHEED MARTIN

100
Concurrent users

50
Projects

The architecture of OpenMBEE proves to be enterprise scalable and has so far greatly satisfied our operational needs.

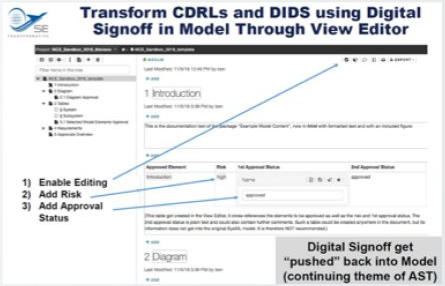
Brittany Friedland, John Herrold, Barry Overcash
Systems Engineering Architects
The Boeing Company

Academia Impact: Inter-Organizational Collaboration

SYSTEMS ENGINEERING RESEARCH CENTER

NAVAIR Model-Based Acquisition Strategy

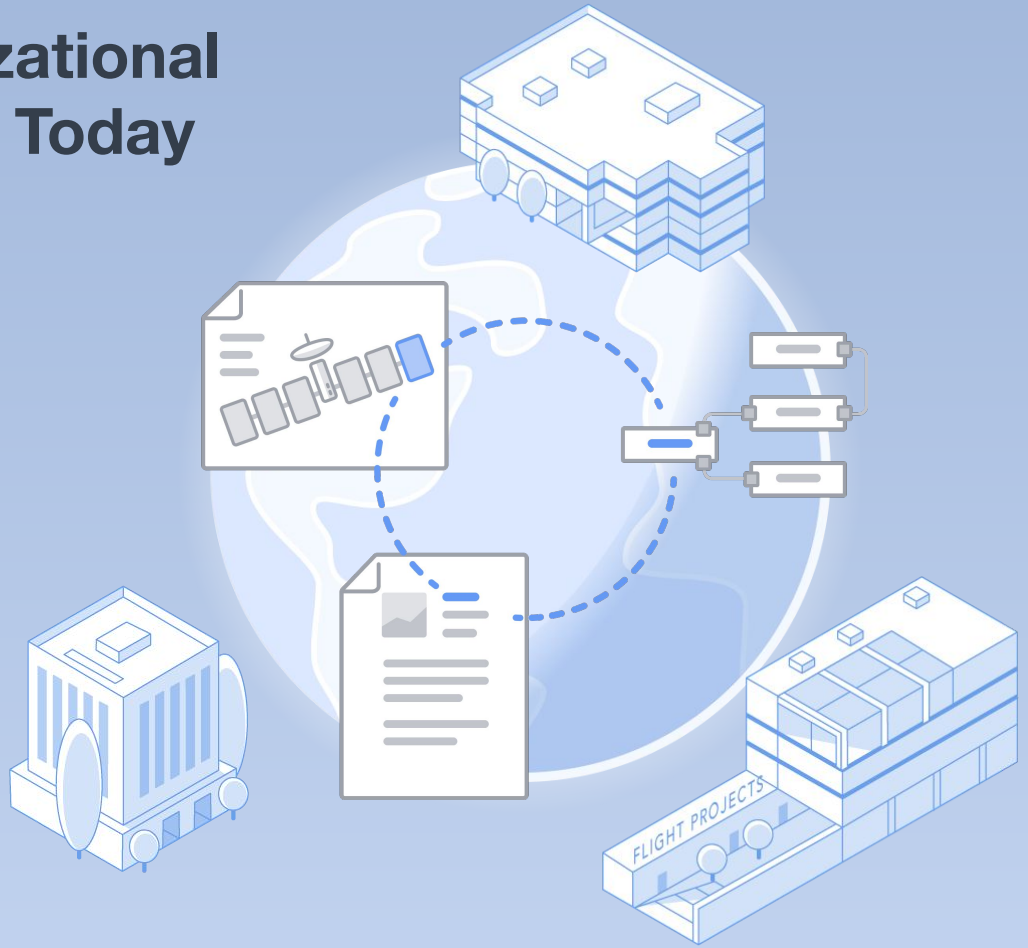
- Surrogate Pilot RFP delivered to NAVAIR
- Data Item Descriptions (DIDs)
- Contract Data Requirements List (CDRL)



...use OpenMBEE View and Viewpoints as a means for placing a Digital signoff directly with model information that provides the needed evidence.

Mark Blackburn, Senior Research Scientist at Stevens/SERC,
Key enabling research on proving MBSE and MBEE for US Navy

Intra-Organizational Environment Today



Inter-Organizational Concept

Mars Sample Return Concept

Global Engineering Ecosystem Vision

Connected engineering information for a connected world

OpenMBEE Updates

- New home with NumFOCUS
- First *International* Workshop on OpenMBEE at MODELS 2020 on October 19, 2020
  Register @ https://www.openmbee.org/models2020
- Architecture in development simplifies software operations while adding new capabilities

OpenMBEE is now a NumFOCUS Sponsored Project

OpenMBEE Vision

- Global Engineering Ecosystem
- Unlock value through commoditization
  - Open / Inner source
  - Discoverable
  - Searchable
  - Learnable

- Provide a standards powered engineering platform using SysML v2 + API & Services

OpenMBEE Vision

- Marry the ubiquity and popularity of programming languages, e.g. Python, with the rigor and durability of systems modeling
- Augment Jupyter's multi-language analysis capabilities with modeling and connected engineering

OpenMBEE Vision

- Enable novel data-driven analyses with advanced capabilities, as a service
  - graph querying
  - distributed computing
  - real time collaboration

Join the community in making this vision into a reality @ openmbee.org


OpenMBEE
Open Model-Based Engineering Environment
Questions?